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The Changing Industrial Organization of Epistemic Communities During Hong Kong's Progression Towards a Cashless Society (1960s-2000s)

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Abstract

The period from the 1960s to c. 2000 saw a dramatic change in retail banking technology in Hong Kong. Initially the relevant technologies were installed and managed within the boundaries of large banks (such as HSBC). But over the course of the period covered by this article, the industrial organization of the relevant technologies transformed to include provision outsourced to non-bank institutions. This paper seeks to account for this shift in the organization of computer technology. Specifically, the paper compares the adoption of computers at HSBC in the 1960s and 1970s with a micro-payments solution called "Octopus", which was developed in the 1990s by a consortium that excluded financial firms thanks to the development in depth and breadth of an epistemic community of computer professionals and computer-literate managers in Hong Kong. Our thinking in doing this comparison was influenced by the theory of the firm as epistemic community.

Keywords: Cashless, banks, industrial organization, HSBC, Octopus, Hong Kong.

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1 Introduction

The term "cashless society" was originally coined in the United States in the mid-1950s to describe a future in which electronic transactions had replaced the use of coins, cheques, and banknotes as media of exchange.[1] A 1966 newspaper article introduced this concept to people in Hong Kong.[2] In the last half century, some societies have evolved towards in this direction, although paper notes and coins are still used in even the most cashless economies, such as Sweden and Iceland.[3] The displacement of cash with other payment solutions is an important topic in the histories of computing and banking: without the digitalization of customer accounts on the back of the adoption of mainframe computers by banks in the 1960s and 1970s, the subsequent moves in the direction of cashlessness would not have been possible.

Although historians have published extensively on the adoption of computers by European and North American banks,[4] they have published far less on the computerisation of East Asian financial institutions.[5] This article helps to fill this gap by exploring the history of retail banking technology in Hong Kong from the 1960s to the present. Although Hong Kong banks lagged behind their American and British peers in computerisation in the 1960s, they rapidly caught up and were early adopters of technologies such as ATMs, telephone banking, and Internet banking. In the early 1970s, Roy Victor Munden, a visionary Hong Kong bank executive discussed the possibility that cooperation between banks and other firms might eventually allow the Crown Colony to evolve into a cashless society.[6] Today, Hong Kong's Octopus system is one of the world's most advanced systems of cashless payments.[7]

Through the examination of two episodes in Hong Kong's computing history, this article indicates how the industrial organization and knowledge base that structured retail banking technology in Hong Kong transformed between the 1960s and the early 2000s.

In the early stages of computerization of retail financial markets, most higher level managers in banks had limited or no knowledge about computer systems although they were already deploying large computer systems on the principle of reducing back-office costs. Computerization predominantly took place by people who trained as bankers and within the boundaries of large corporations, particularly Hong Kong's big commercial banks. During the more recent periods, however, there have come to be a greater diversity of approaches from which to choose when implementing a large application of computer technology in

retail finance. This diversity has emerged to the extent that regulatory and technological change together with new forms to price risk reshaped retail financial markets. Some of these changes have enabled specific instances in which non-financial intermediaries take the lead in the innovative use of computer technology and successfully contest retail bank markets. For instance, the use of cellphones as cashpoints in Kenya.[8] But relevant to the aims of this article is the inter-firm networks that enabled Octopus within Hong Kong's retail payment system. To exemplify two stages in the adoption of computer technology in Asian retail banking, this article compares and contrasts the "internal" deployment of early computers at HSBC in the 1960s and 1970s, with the "external" (i.e. non-bank or market) use of computers in micro-payments (using the Octopus chip) in the 1990s and 2000s. By documenting these two episodes of technological change we indicate not only a dramatic transformation in the nature of the organisations responsible for the transformation of Hong Kong's retail banking technology, but also how the institutional shift reflected changes in the nature of the knowledge related to computers. We describe these two episodes in sections 3 and 4.

2 About Large Corporations and Epistemic Communities

To compare and contrast the aforementioned two episodes of technological evolution we draw on the variant of the knowledge-based theory of the firm developed by Lars Håkanson in his work on the industrial organization of epistemic communities. For readers not familiar with his framework, we outline Håkanson's concepts and show his views differ from the more established transaction-costs approach to understanding industrial organization pioneered by Oliver Williamson. Drawing on Ronald Coase's theory of the firm, Williamson used transaction costs to explain why some activities are coordinated by markets while others take place within firm boundaries. In their view, high transaction costs are the primary reason why participants would replace the "invisible hand" of the market with managerial hierarchies.[9] Williamson argued that transaction costs, and thus one's preference for hierarchies over markets, are likely to be high if one or more of the following conditions is present: high asset specificity, thin markets, difficulties in negotiating and writing enforceable contracts, and asymmetric information between contracting parties.

We agree that a Williamsonian approach is of some use in understanding the transition described in this article, as the relevant markets were quite "thin" in Hong Kong and elsewhere in the 1960s and 1970s. The relevant markets here are the markets for

computers and the specialized skills needed to operate them. By "thin", we mean there were an insufficient number of specialist vendors to make the market truly competitive. By the 1980s, the markets for computer hardware and skills were much "thicker", which contributed towards a shift towards the deployment of retail payment technologies in looser, inter-firm networks, such as the inter-firm network that developed Hong Kong's Octopus system. The increasing thickness of markets often encourages firms to dis-integrate vertically and adopt other models for coordinating production, as thick markets make firms less susceptible to the so-called "hold up" problem.[10]

However, transaction costs are only part of the explanation. Instead of using the ideas of Williamson, we draw on Lars Håkanson's ideas about epistemic communities, which are much newer concepts in management research. Håkanson synthesizes the knowledge-based view (KBV) of the firm[11] with Burkart Holzner's work on the sociology of knowledge.[12] In Håkanson's work[13], epistemic communities are systems that allow their members to interpret the world. Since individuals use multiple and layered frameworks to make sense of observed reality, we are all members of many epistemic communities. As an indiviual progresses from infancy through schooling and into an occupation, one joins various epistemic communities. Languages structure how their speakers think, and language communities are thus epistemic communities, albeit large ones that comprise everyone living in a community save for very small children. Smaller epistemic communities include the learned professions, skilled trades, industrial clusters and in some cases, as Håkanson[14] documented, individual firms. Through the process of organizational learning, a firm can join an epistemic community. Within the boundaries of each of these more specialized epistemic communities, there is a unifying set of knowledge that includes common terminology, acceptance of other, non-linguistic conventions, and knowledge of how to perform particular productivity tasks. This shared knowledge permits a more advanced division of labour.

Håkanson discusses *articulation*, the process by which tacit knowledge becomes "explicit" as standards and other tools (e.g., operating manuals or blueprints that can be shared with other firms). Articulation encompasses standardization and the development of technical jargon, or a common vocabulary precise enough to permit cooperation across firm boundaries (e.g., the intra-firm and international consensus about the exact physical characteristics of a credit card). It is difficult to have extensive outsourcing without some degree of articulation: articulation facilitates the division of labour. Closely associated with articulation in Håkanson's framework is *replication*, which involves the transfer of

knowledge and thus capabilities. In Håkanson's view, articulation and replication facilitate the creation of "well defined, standardized interfaces between epistemic communities" which thereby "increase the feasibility of knowledge combinations through the uncomplicated transfer across epistemic boundaries of physical artefacts, such as blueprints or components."[15]

The boundaries of epistemic communities do not determine industrial organization but they influence it. Håkanson observes that "the cost of governing knowledge processes depends as much on the cognitive background of the exchange partners as on the tacitness of the knowledge."[16] In other words, it is more challenging to trade with an individual who is outside of most of one's epistemic communities than with someone who is a member of most or all of the same epistemic communities. Whenever the boundaries of the relevant epistemic communities align perfectly with those of the individual firm, there will be a strong incentive for productive activity to be coordinated within the boundaries of the company, since transaction costs with outsiders are likely to be elevated. In contrast, epistemic communities "that span organization boundaries create and legitimize common codes and cognitive frames…" thereby facility the exchange of knowledge between organizations.[17] The relative ease with which knowledge flows within epistemic communities changes transaction costs and thus influences decisions about whether productive activities are to be done within the boundaries of a single organization or in looser "networks of practice".[18]

Members of several overlapping epistemic communities have managed the technologies that have facilitated the digitalization of retail banking over the last half century. Turning back to Hong Kong, when the first computer was installed in 1963, the computer-literate population of the Crown Colony was confined to a handful of individuals. The epistemic community of computer literate-people consisted of just several small pools of talent, each confined to just a few firms. Within each firm, the information and communication technologies (ICT) professionals knew how to operate a single manufacturer's proprietary hardware and software. The managers who supervised these professionals had only the most rudimentary computer literacy. Digital systems for moving money were contained within the boundaries of individual banking firms. This meant, for instance, that terminals in the tellers of bank branches could communicate and exchange information with a mainframe in the head office, but not with computers in other firms. In the 1970s, customers of a given Hong Kong bank could not use the cashpoints of another bank. Over the next few decades, the epistemic community of ICT professionals would grow

rapidly as the proportion of Hong Kong adults who were computer-literate increased. As this epistemic community increased in depth (i.e. number of participants and diversity of specialisms), the pools of knowledge expanded and grew across the boundaries of firms to include many individuals in a wide range of firms.

In the 1990s, firms as diverse as banks and public transport companies worked together to develop the Octopus network, the payments system that has helped Hong Kong people to reduce their usage of cash. This system then grew while working in cooperation with firms including convenience store and fast food restaurant chains. We argue that the inter-organization cooperation represented by the Octopus system was facilitated the prior emergence of two inter-firm epistemic communities in Hong Kong: ICT professionals capable of communicating across firm boundaries and computer-literate managers capable of supervising their professionals and communicating with their counterparts in other firms. The growth of common industrial standards and interoperable systems which contributed to the ability of firms to cooperate in the implementation of general-purpose computing technologies also enabled further progress in the transition towards cashlessness in Hong Kong.

3 Episode 1: Internal Computerisation

In this section we use one company, China Light and Power (CLP), to illustrate the situation before inter-organizational epistemic communities. The first organization in Hong Kong to acquire a computer was CLP, a local utility. It took delivery of an NCR315 system in late 1963 and then began experimenting with various applications of the technology. By 1965, CLP was sending computer-generated bills to its customers.[19] The Crown Colony's second computer arrived at Hong Kong University in 1965.[20] As late as 1965, experience with computers in Hong Kong was confined to just these two organizations. There is no evidence that these two organizations cooperated on solving computer problems or otherwise formed a single epistemic community of knowledge and practice.

Hong Kong's banks became interested in computers largely in response to the rapid expansion of their customer base. In the 1950s and 1960s, the proportion of Hong Kongers with bank accounts increased dramatically.[21] By the mid-1960s, there was roughly one bank account for every person in Hong Kong.[22] The growth of their retail basis posed major organizational and technological challenges for the colony's banks which were forced to

expand their retail branch networks.[23] The challenges were particularly acute at HSBC, the colony's largest bank. By early 1965, there were thirty-one HSBC retail branches and sub-branches in Hong Kong.[24] With a growing customer numbers, keeping track of balances became a cumbersome administrative process. Speaking of this period, a retired HSBC executive later recalled that in some retail branches, the staff were required to stay at work "till ten, eleven o'clock at night a week at a time" to do all of the relevant calculations. He also remembered that these long hours had cost the bank significant sums in overtime.[25]

Mechanization and later computerisation were among the bank's responses to the problem of handling a rapidly growing number of transactions.[26] In the 1950s, HSBC decided to replace traditional ledgers with National Cash Register (NCR)'s new Post-Tronic system for keeping track of customer accounts.[27] HSBC's managers appear to have become aware of the importance of computers to banking at an internal conference in 1958 at which a they discussed an NCR brochure about bank automation.[28] Computers were then adopted during the leadership of Sir John Anthony Holt Saunders (1917-2002).[29] As chief executive of the bank between 1962 and 1972, Saunders came to regard computerisation as vital for the future of the bank. Saunders's interest seems to have developed after a visit to the United States in the mid-1960s, where he met with US bank presidents. Saunders was repeatedly asked about HSBC's use of computers but was unable to say much in response to these enquiries as HSBC did not yet have any computers. Saunders returned to Hong Kong impressed with the need to keep up to date with US banks.[30] It should be noted that HSBC had recently expanded into the US market and was also facing increasing competition in Asia from Chase Manhattan, a US bank. [31]

Title: Sir John Anthony Holt ("Jake") Saunders, 1917-2002 (chief manager from 1962; chairman HSBC, 1964-1972)

Source: Wikimedia Commons (n/d)[32]

Saunders appears to have known little about computers, which he referred to as "bloody things."[33] He nevertheless understood that computers were important and was willing to authorise considerable expenditure on them. Given his unfamiliarity with this unpredictable new product, it is not surprising that computerization at HSBC during Saunders's tenure as CEO took place exclusively within the boundaries of the firm. In order to learn more about which computer technology to adopt, Saunders set up a Methods & Research (M&R) unit to study the use of computer technologies.[34] The creation of this advisory unit brought HSBC along the same lines as large British banks.[35] In 1964, Saunders then assigned the task of supervising computerisation to Norman Howard Talbot Bennett (born 1921).

Bennett, who was four years younger than Saunders, knew only slightly more about computers. He had begun his career with Barclays Bank in London and joined HSBC in 1946 where he then held a number of posts in India, Hong Kong, Singapore, and Thailand over the next two decades. Bennett supervised the M&R team that negotiated the bank's first contract with IBM in December 1965.[36] A key point here is that Bennett had left the United Kingdom before the British banking industry began introducing electronic computers in the late 1950s. Bennett had, therefore, been isolated from these developments. It is probably that at the moment in 1964, when Bennett was given responsibility for managing HSBC's adoption of computers, he had never seen an actual computer, as he had spent the last two decades living in developing countries in which this technology had yet to arrive. Moreover, Bennett also lacked any formal training in any of the academic disciplines, such as mathematics or engineering, that might have prepared him for work with calculating devices. Thus, while some British bankers were acquiring enough knowledge of computers to move into the epistemic community of "the computer literate," Bennett was well outside the admittedly nebulous boundary of this social category.

Bennett's formal title changed on a number of occasions: in the four years after 1964 he was successively Controller with Special Duties, Chief Manager's Assistant, and then Assistant to the Chairman. Regardless of the changes in this title, his basic function remained the same: in the period between 1964 and 1970, Bennett's focus was on managing computerisation. It appears that Bennett's main source of information about computers was a friend who worked for the National Westminster Bank, a British domestic bank that had already migrated several administrative tasks to computers. [37] Bennett's conversations with

his friend, which likely took place during a holiday in the United Kingdom, appear to have represented the extent of his education with computer technology prior to his 1964 appointment.

Source: HSBC Archives (circa 1970)

In Bennett's view, the first major benefits HSBC derived from computerisation came from the December 1965 decision to link terminals in each branch to an IBM 360 computer in the headquarters via telephone lines. This important decision permitted "real time" on-line management of accounts. HSBC was not the first bank to link computers in branches via telephone lines, as a similar system had been adopted in 1961 by the Bowery Savings Bank in New York City. IBM's Robert Osborn, a leading figure in the development of real-time computer systems, visited IBM's Hong Kong office and met with Bennett and other HSBC staff in May 1965.[38] HSBC executives were also aware that a consortium of New Zealand banks called Databank Systems Ltd was also working on a real-time system. Bennett flew to New Zealand and interviewed Databank CEO Gordon Hogg in the course of planning HSBC's network.[39] The Databank System went live in 1967, the same year the IBM mainframes were installed in HSBC's headquarters and linked to terminals in the branches.[40]

As was usual with IBM, "big blue" sent HSBC technical advisors to help with teething problems during installation.[41] For instance, IBM's staff helped HSBC to select promising clerical employees (many of whom were refugees from mainland China without

secondary education), for training as computer programmers. IBM staff then helped to deliver the training needed to convert clerks into programmers. Bennett opined in 1980 that retraining of existing HSBC employees as programmers was important for HSBC's computerisation drive.[42] Instrumental to success, however, was also the hiring of three experienced personnel from the UK: the electronic data processing (EDP) Manager, Chief Analyst, Chief Programmer, who nurtured and led the inexperienced local staff to complete the project.[43]

Source: HSBC Archives, 1975

4 Episode 2: The Octopus System

4.1 The market thickens in Hong Kong, 1970s-1990s

The previous section argued that HSBC adopted computers in the late 1960s and early 1970s primarily as a way of managing a growing number of savings accounts more effectively. About this process Bennett recollected that while computerisation had not deprived any HSBC worker of a livelihood, it had allowed the bank to reduce overtime and direct employees' energies towards more profitable activities.[44] At this point in time, the computer-literate population of Hong Kong consisted primarily if not exclusively of workers who had been trained to use a single proprietary system.

In contrast to the story told in episode one, the level of knowledge about computers within and around Hong Kong's banks rose significantly over the course of the next couple of decades. By the 1980s there were many highly-educated people familiar with both the fundamental principles of computing and a variety of hardware and software products. The markets for computer technology and computer expertise were much thicker, which permitted

outsourcing[45] and vertical disintegration. The technology was much less expensive and was better understood.

To adopt Håkanson's terminology, an epistemic community that included ICT professionals and managers in many Hong Kong firms had been formed. Higher education institutions played an important role in the creation of this inter-firm epistemic community by training young people with general computer skills. They were producing large numbers of computer science graduates who could be employed by firms to help them to understand and manage these technologies, which no longer seemed exotic. For instance, the University of Hong Kong (UHK), an English-language institution, offered instruction in computers to students in a variety of disciplines from 1967 onwards using an IBM 1620.[46] In 1968, the Chinese University of Hong Kong (CUHK) began offering courses in computer programming. The CUHK established a full-fledged Department of Computer Science in 1973 and began offering a degree in Computer Science in 1978.[47] In 1970, UHK and CUHK began inter-organization cooperation in computing with the establishment of the Joint Universities Computer Centre (JUCC). Computer lessons became part of the secondary school curriculum in the early 1980s.[48]

The Hong Kong Computer Society (HKCS) also helped to create an epistemic community of ICT professionals that extended across the boundaries of firms. The HKCS was established in 1970 through the cooperative efforts of HSBC, IBM, and other large companies.[49] In 1970, HSBC was represented on the board of the HKSC by two executives, including J.P. Rastello, the manager of the bank's data processing centre.[50] Many of the founders of the HKCS were expatriates, although it soon acquired a large number of Chinese members.[51] The HKCS took steps to promote greater awareness of computers by the other specialists and the general public. For instance, in 1970, Rastello publicly declared that Hong Kong urgently needed more computer programmers and urged cooperation by various stakeholders to achieve this goal.[52] Echoing Rastello's sentiment and in direct response to increased demand for knowledge about computers in Hong Kong, the HKSC began publishing a newsletter. In 1974, the HKCS formed a Computer Audit Club with the Hong Kong Society of Accountants.[53] After 1978, the HKSC actively facilitated the exchange of knowledge about computers between individuals in different firms and other organizations through an annual convention.

Over the course of the 1970s, a growing number of firms and individuals in a variety of Hong Kong industries began using computers, either by purchasing their own devices or contracting the work out to computer service bureaux. The latter appeared as early as 1970 when HSBC and Standard Chartered began to offer these services to their business customers.[54] The middle years of the decade appear to have been an inflection point for the development of epistemic communities ICT professionals and computer-literature managers in Hong Kong. A study by Eric Kwong-kay Lo, on the number of computers deployed across Hong Kong's industries in the mid-1970s, estimated that the number of computers in use in Hong Kong's large businesses increased from 119 at the end of 1975 to 266 at the end of 1977.[55] The same study also suggested that the adoption of computers did not occur at a uniform rate in all sectors of the colony's economy. In banking and public utilities, which had adopted computers in the 1960s, the annual rate of increase in the number of computers was modest compared to that in the ship construction, chemical, and architectural sectors, where firms acquired computers at a much higher rate in the period 1975-7. Mr Lo's study implies that small retail establishments and restaurants in Hong Kong did not experience any computerisation in this span of years.

Verifying Mr Lo's estimates of computer penetration levels is difficult, as Hong Kong's government generated few statistics about computer sales or usage in this period.[56] As a result, we cannot systematically compare the competitiveness of the colony's ICT markets across time or with those of other jurisdictions. Anecdotal evidence, however, allows us to infer that Hong Kong's market for computer components became highly competitive in the 1980s. For instance, in 1984, Hong Kong had a thriving market for legitimate and pirate computer components for Apple II and IBM PC systems.[57] We know that the number of computer vendors increased dramatically in Hong Kong during the 1980s, when specialised shopping districts for computer components emerged. The most important of these was the area that came to be known as the Mongkok Computer Centre.[58] At the same time, Hong Kong's Golden Arcade emerged as a centre for PC-clone distributors and software vendors.[59] In a 1992 article about the Golden Arcade, a *South China Morning Post* reporter noted the intensively competitive nature of the market, which was characterised as a "Darwinian bloodfest… competition is cut-throat and margins razor-thin."[60] This colourful language indicates that markets had become quite thick. By 1990, Hong Kong's Trade Development Council discussed "the increasing commoditization of personal computers, peripherals and even facsimile machines."[61]

All of these developments in Hong Kong were, of course, influenced by global developments in the broad field of information and communication technologies.[62] During this period, the epistemic communities that worked with computers underwent changes that correspond to the processes of *articulation* and *replication* identified by Håkanson. These developments facilitated the shift in the way in which retail banking technology was operationalized in Hong Kong: no longer was the entire process done within the boundaries of a single firm, now looser networks were used. This new approach was exemplified by the Octopus system.

4.2 The Octopus system and the big problem of small change

By the 1990s, computers were a fact of life in firms in many Hong Kong industries. It was in this context that the inter-firm network known as the "Octopus system" emerged. Launched in 1997, it rapidly grew to become the preferred solution for "micro-payments" in Hong Kong. Many consider the success of Octopus as a decisive step of the colony's transition to a cashless society. [63]

The origins of Octopus lie in the fact that, like retail banks, public transport authorities face the problem of dealing with a very high volume of standardised transactions. Early computer systems were inadequate for such tasks.[64] This limitation was overcome with the advent of Tandem's so called "non-stop" computing and the development of fault resilient systems by other manufacturers during the 1980s. Prior to the advent of such systems, transport authorities in many countries had been to automate fare collection by using cardboard tickets with a magnetic stripe.[65] In Hong Kong, the magnetic stripe ticketing system was introduced in 1979 on the Mass Transport Railway (MTR) Corporation's subway network.[66] In 1983, the MTR introduced the Common Stored Value Ticket (CSVT) to supplement single journey passes. Regular commuters could then purchase fixed value magnetic stripe cards that could be used until the balance on the card was depleted, thus allowing for multiple journeys in a single ticket. The CSVT both improved customer service and reduced the number of coins the company was required to handle.[67]

By the early 1990s, MTR's CSVT tickets could be used on the Kowloon-Canton Railway (KCR), a separate company. Bus companies began adopting the system in 1989, giving customers another place to spend value stored on their CSVT ticket.[68]

Title: Octopus chip reader in public transport

Source: Wikimedia Commons (n/d)[69]

4.3 Birth of the Octopus system

In 1992, MTR executives began searching for a replacement to the CSVT system which had technical problems that included a fault rate of 1 for every 2,500 transactions.[70] These faults were costly in a system handling some two million transactions a day. Chip-based card technology looked as an attractive proposition. Its commercial application had been pioneered by France Telecom in the 1980s.[71] This near-field technology[72] offered ease of use and speed: fulfilling transactions within 300ms without having to actually touch readers.[73] Transactions were accurate and there were safeguards against fraud. End-of-day account settlement reduced human counting errors and bank settlement time. The MTR executives decided that it made sense to introduce the new solution across the public transport systems (ferries, trains, subway, taxi, bus, min-bus, trams) operated by different companies.[74] This plan required bringing together competing transport operators to collaborate on a single payment scheme. In other words, a precondition of Octopus was establishing a community that cooperated across firm boundaries to *articulate* a common payment standard. Octopus was possible because inter-firm epistemic communities of ICT professionals and computer-literate managers with a common terminology and references had emerged in Hong Kong by this point.

In 1994, five major public transport operators namely, the two rail lines, MTR and KCRC, bus companies KMB and Citybus; and the Hongkong and Yaumatei Ferry (HYF), established a joint venture, "Creative Star Limited" (renamed as "Octopus Cards Limited" in 2002, henceforth Octopus), to oversee the contactless smartcard system's development and implementation.[75] This "organizational and governance structure… gave all players (no

matter how small) a very significant say [in the development of the payments solution]."[76] Professional service provider Pricewaterhouse Coopers (PwC) helped to design the governance structure. PwC also acted as intermediary with the banks, who transferred critical technical knowledge to Octopus that allowed the new network to be linked back to the pre-established payments ecosystem. For consumers, this meant that funds could be transferred easily and electronically from bank accounts to Octopus cards.

Title: Vending machine activated by Octopus chip

Source: Wikimedia Commons (n/d)[77]

The Octopus card debuted in 1997. The hardware was partially purchased "off the shelf", partly developed in-house. For instance, while Octopus adopted Sony's smartcard technology, it developed most of its terminals in-house.[78] The software resulted from a combination of in-house development and ready-made packages. Rail and underground passengers already accustomed to stored value cards with the CSVT readily accepted the new payment solution.[79] In 2000, the owners of Hong Kong's six million Octopus chips acquired the ability to use them on 4,100 buses owned by small and big operators. This extension of the payment network was followed by acceptance by the 600 or so companies running mini-buses.

In yet another sign of *articulation* across firms, Octopus-compatible readers began to the connected to machines owned by companies that were not part of the consortium that had created the Octopus system. Vending machines inside stations and then shops and restaurants

allowed users to spend value stored on the Octopus cards on products other than transport. In 2002, Octopus payments for non-transport uses amounted to HK$1.1 billion, or 6% of all Octopus transactions. By 2010, Octopus payments for non-transport had risen to HK$15 billion, or 61% of all Octopus transactions.[80]

By 2011 there were 5,000 readers deployed across 3,000 different merchants accepting payment through Octopus.[81] In that year, there were 23 million Octopus chips in circulation. On average, each card was used eleven times per day, with the average value per transaction being $HK9.00 (approximately US$1.16).[82] Moreover, each card's unique identifier enabled its use as a personal identification device. Designated individuals could thus use their cards to activate lifts in the lobby of the International Financial Centre, book and pay for public tennis courts and swimming pools, or even enter a keyless private residence.[83]

Title: Access to apartment building activated by Octopus chip

Source: Wikimedia Commons (n/d)[84]

5 Conclusion

In the 1960s, the first computers were installed in Hong Kong banks. The first section of this article documented the introduction of these technologies was largely done within the boundaries of firms: executives at firms such as HSBC decided not to develop cooperative networks involving other banks. One benefit of this approach was that it increased the bank's degree of self-reliance. HSBC's approach was influenced by the fact the relevant markets for computer components and ICT skills were then quite thin in Hong Kong. Moreover, while managers in Hong Kong financial institutions anticipated that computers were important, they were unfamiliar with the technology, which was novel, very expensive, and only poorly

understood by managers, most of whom had grown to adulthood before the Second World War.

By the 1980s and 1990s, the situation in Hong Kong had changed and now permitted sub-contracting and extensive outsourcing. By this point, the local markets for computer technology and computer expertise were much thicker. The storage and processing capacity of computers had grown exponentially while, at the same time, they were much cheaper (in nominal prices). Moreover, the human capital needed to effect this transition had become less scarce, thanks in part of the advent of computer science courses in Hong Kong universities. The epistemic community of relevant ICT professionals now included individuals working a wide range of Hong Kong firms. These developments facilitated the shift in the way in which retail banking technology was operationalized in Hong Kong: no longer was the entire process done within the boundaries of a single firm, now looser networks, such as the Octopus system, were used. The industrial organization of cashless payment technology in Hong Kong changed in part because of the growing size of the relevant epistemic community: by the 1990s, the epistemic community in question had expanded to include individual in a wide variety of non-financial companies, most notably the public transport operator. The creation of this epistemic community was, as this paper has shown, a precondition of the success of the Octopus payment system.

BIOS

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NOTES

[1] B. Bátiz-Lazo, T. Haigh, and D. L. Stearns, "How the Future Shaped the Past: The Case of the Cashless Society," *Enterprise and Society* 15:1 (2014), pp. 103-131. The same source also notes that initially cashless and checkless were used indistinctively.

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